Quantum fluctuations lead to glassy electron dynamics in the good metal regime of electron doped $KTaO_3$

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One of the central challenges in condensed matter physics is to comprehend systems that have strong disorder and strong interactions. In the strongly localized regime, their subtle competition engenders glassy electrons, which ceases to exist well before the insulator-to-metal transition is approached as a function of doping. In this talk, I will present our recent finding of glassy electron dynamics deep inside the good metal regime of an electron-doped quantum paraelectric system: $KTaO_3$. We reveal that upon excitation of electrons from defect states to the conduction band, the excess injected carriers in the conduction band relax in a stretched exponential manner with a large relaxation time, and the system evinces simple aging phenomena - a telltale sign of glass. Most significantly, we observe a critical slowing down of carrier dynamics below 35 K, concomitant with the onset of quantum paraelectricity in the undoped $KTaO_3$. Our combined investigation using second harmonic generation technique, density functional theory and phenomenological modeling demonstrates quantum fluctuation-stabilized soft polar modes as the impetus for the glassy behavior. This study addresses one of the most fundamental questions regarding the potential promotion of glassiness by quantum fluctuations and opens a route for exploring glassy dynamics of electrons in a well-delocalized regime.

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